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Roughness of biopores and cracks in Bt-horizons by confocal laser scanning microscopy

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During preferential flow events in structured soils, the movement of water and reactive solutes is mostly restricted to larger inter-aggregate pores, cracks, and biopores. The micro-topography of such macropores in terms of pore shapes, geometry, and roughness is crucial for describing the exchange of water and solutes between macropores and the soil matrix. The objective of this study was to determine the surface roughness of intact structural surfaces from the Bt-horizon of Luvisols by confocal laser scanning microscopy. For this purpose, samples with the structural surface types including cracks with and without clay-organic coatings from Bt-horizons developed on loess and glacial till were compared. The surface roughness of these structures was calculated in terms of three parameters from selected surface regions of 0.36 mm^2 determined with a confocal laser scanning microscope of the type Keyence VK-X100K. These data were evaluated in terms of the root-mean-squared roughness, Rq, the curvature, Rku, and the ratio between surface area and base area, RA. Values of Rq and RA were smaller for coated as compared to uncoated cracks and earthworm burrows of the Bt-horizons from both parent materials. The results indicated that the illuviation of clayey material led to a “smoothing” of the crack surfaces, which was similar for the coarser textured till-Bt and the finer-textured loess-Bt surfaces. The roughness indicated by Rq and RA values was only slightly smaller and that indicated by Rku slightly higher for the structural surfaces from the loess as compared to those from the glacial till. These results suggest a minor importance of the parent material on the roughness of structural surfaces in the Bt-horizon. The similarity of Rq, RA, and Rku values between surfaces of earthworm burrows and uncoated cracks did not confirm an expected smoothing effect of the burrow walls by the earthworm. In contrast to burrow walls, root channels from the loess-Bt were smoother than the surfaces of the other structure types, suggesting that the two types of biopores have to be distinguished when describing preferential flow and macropore-matrix exchange. Nevertheless, the confocal laser microscopy technique proved useful for characterizing the roughness of intact structural surfaces.